Mem. S.A.It. Vol. 84, 606

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Swift monitoring of IGR J16418–4532

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Abstract. We report on the *Swift* observations of the candidate supergiant fast X-ray transient (SFXT) IGR J16418–4532, which has an orbital period of ∼3.7 d. Our monitoring, for a total of ∼43 ks, spans over three orbits and represents the most intense and complete sampling along the orbital period of the light curve of this source. If one assumes a circular orbit, the X-ray emission from this source can be explained by accretion from a spherically symmetric clumpy wind from a blue supergiant.

Key words. X-rays: binaries - X-rays: individual (IGR J16418−4532)

1. Introduction

Supergiant Fast X-ray Transients (SFXTs) are a class of high-mass X-ray binaries with OB supergiant companions. Their hallmark is the occurrence of short (∼hours) outbursts during which the luminosity can increase by 3–5 orders of magnitude (typically, up to 10^{37} erg s^{-1}). Either the clumpy structure of the wind from the companion or a centrifugal and/or magnetic gating have been suggested to be responsible for the outbursts.

IGR J16418–4532 is a hard-X-ray transient discovered by *INTEGRAL* in 2003 and later tentatively classified as an SFXT on the basis of its outbursting behaviour (Sguera et al. 2006). At soft X-rays *XMM–Newton* observations showed a heavily absorbed pulsar with $P_{\rm spin} \simeq 1.25$ ks (Walter et al. 2006). An orbital periodicity of ∼3.74 d was discovered with the *Swift*/BAT and the *RXTE*/ASM (Corbet et al. 2006; Levine et al. 2011) and a hint of a total eclipse, consistent with a supergiant companion, has been observed in the BAT data. We analyzed all the *Swift* data collected on IGR J16418–4532, including a monitoring campaign carried out in 2011 July that spans over three orbital periods.

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2. Results

For the binary orbital period analysis we used the 15–50 keV BAT Transient Monitor (Krimm et al. 2006) light curves collected from 2005 February 12 to 2011 July 12. Fig. 1 (left) shows the epoch-folded BAT light curve for $P_{\rm orb}$ = 3.73886(28) d and MJD 53560.20000 as $T_{\rm epoch}$ (Corbet et al. 2006; Levine et al. 2011). The BAT data show an eclipse centred at phase $\phi \sim 0.55$. The depth is consistent with a total eclipse, and the eclipse FWHM duration is $\Delta\phi = 0.17 \pm 0.05$ of the orbital period.

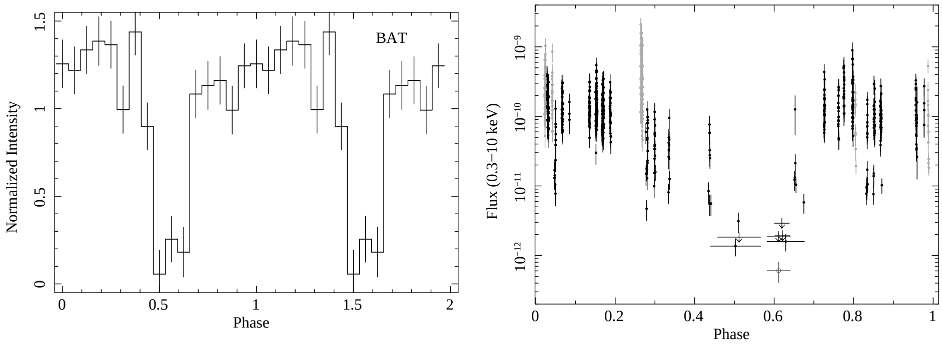

Fig. 1. BAT (left) and XRT (right) epoch-folded light curves. Arrows are 3σ upper limits. The open circle, a detection obtained by combining three observations, corresponds to a flux of $\sim 6.0 \times 10^{-13}$ erg cm^{-2} s^{-1}. The maximum observed count rate corresponds to 2.1×10^{-9} erg cm^{-2} s^{-1}.

Fig. 1 (right) shows the 0.3–10 keV XRT epoch-folded and background-subtracted light curve of the whole 2011 July campaign. In order to convert count rate to flux, we adopted conversion factors derived from spectral fits of each observation (see Romano et al. 2012 for more details). The data start at phase 0.16 and cover three full periods. Superimposed on the long-term orbital modulation, which follows that seen with BAT, flaring is observed on short time scales (a behaviour typical of most SFXTs). In particular, the eclipse lasts $\Delta\phi \sim 0.2$ and is centred at $\phi \sim 0.55$.

3. Discussion

The *Swift* folded light curves of the source show a dip that, if interpreted as an eclipse, can be used to infer the nature of the companion star. Assuming for simplicity a circular orbit, we concluded that the primary is an O8.5I supergiant star (with mass, radius, luminosity, effective temperature given by Martins et al. 2005, $M_{\rm OB} = 31.5\,{\rm M}_{\odot}$, $R_{\rm OB} = 21.4\,{\rm R}_{\odot}$, $\log L_{\rm OB}/L_{\odot} = 5.65$, $T_{\rm eff} = 32.3 \times 10^3$ K) and that the distance to IGR J16418–4532 is ~13 kpc (Rahoui et al. 2008). See Romano et al. 2012 for more details.

The XRT light curve shows a large dynamic range, up to 1–2 orders of magnitude within a single snapshot and of at least 3 orders of magnitude overall (even when the eclipse is excluded). This dynamic range is typical of 'intermediate' SFXTs. We found that the observed X-ray variability can be reproduced by the clumpy wind model by Ducci et al. (2009) with the following parameters: mass loss rate $\dot{M}_{\rm tot} = 6 \times 10^{-7}\,{\rm M}_{\odot}\,{\rm yr}^{-1}$, terminal velocity $v_{\infty} = 1000\,{\rm km\,s}^{-1}$, fraction of mass lost in clumps $f = 0.9$, mass distribution power-law index $\zeta = 1.1$, power-law index of the initial clump dimension distribution $\gamma = -1$, minimum clump mass $M_{\rm a} = 5 \times 10^{18}$ g and maximum clump mass $M_{\rm b} = 10^{20}$ g (see Romano et al. 2012 for further acceptable solutions). This further strengthens the interpretation of IGR J16418–4532 as an intermediate SFXT.

Acknowledgements. See the Swift Supergiant Fast X-ray Transients Project page at `http://www.ifc.inaf.it/sfxt/`.

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